Coastal Throughput Modeling
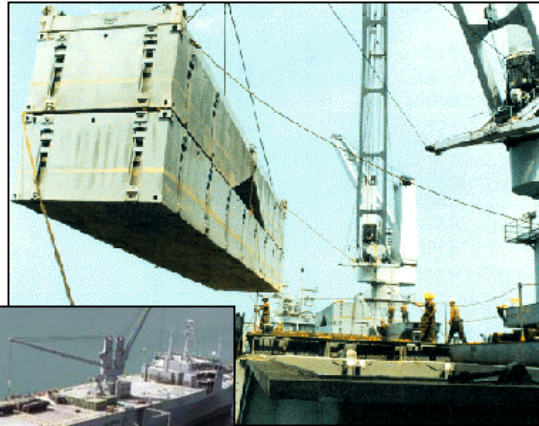
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Computer Specialist

US Army ERDC

Coastal & Hydraulics Laboratory

Perspective

- **History**
  - **Former throughput models/shortfalls**
  - **Why develop CITM?**

- **Present**
  - **development timeline/current capabilities**

- **Future**
  - **Future uses of CITM class model**
  - **Development of small port models**

Methodologies for JLOTS M&S

In the 1990's there were several different methodologies for throughput prediction and analysis

- **Linear algebra**

- **Virtual reality**

- **Integrated model concepts (time stepping)**

Force Projection – "a system of systems"

- **Very complex**

- **Very non-linear**

- **Extremely affected by environmental conditions**

CITM was developed (1998-2001) with RDT&E funding as a time-domain tool to help provide accurate answers
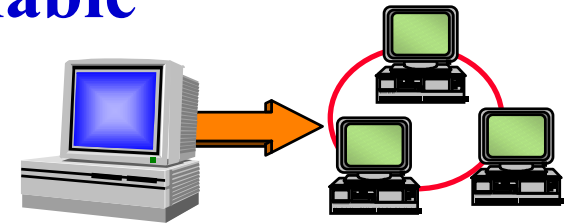
Purpose

Tool to evaluate force projection capabilities when deep-draft ports are unavailable

- ◆ **Conventional JLOTS**
  - ◆ **Lift-On/Lift-Off**
  - ◆ **Roll-On/Roll-Off**
- ◆ **Emerging technologies**
  - ◆ **Theater Support Vessel (TSV)**
  - ◆ **Enhanced small ports**
- ◆ **Identification of limiting factors to throughput**
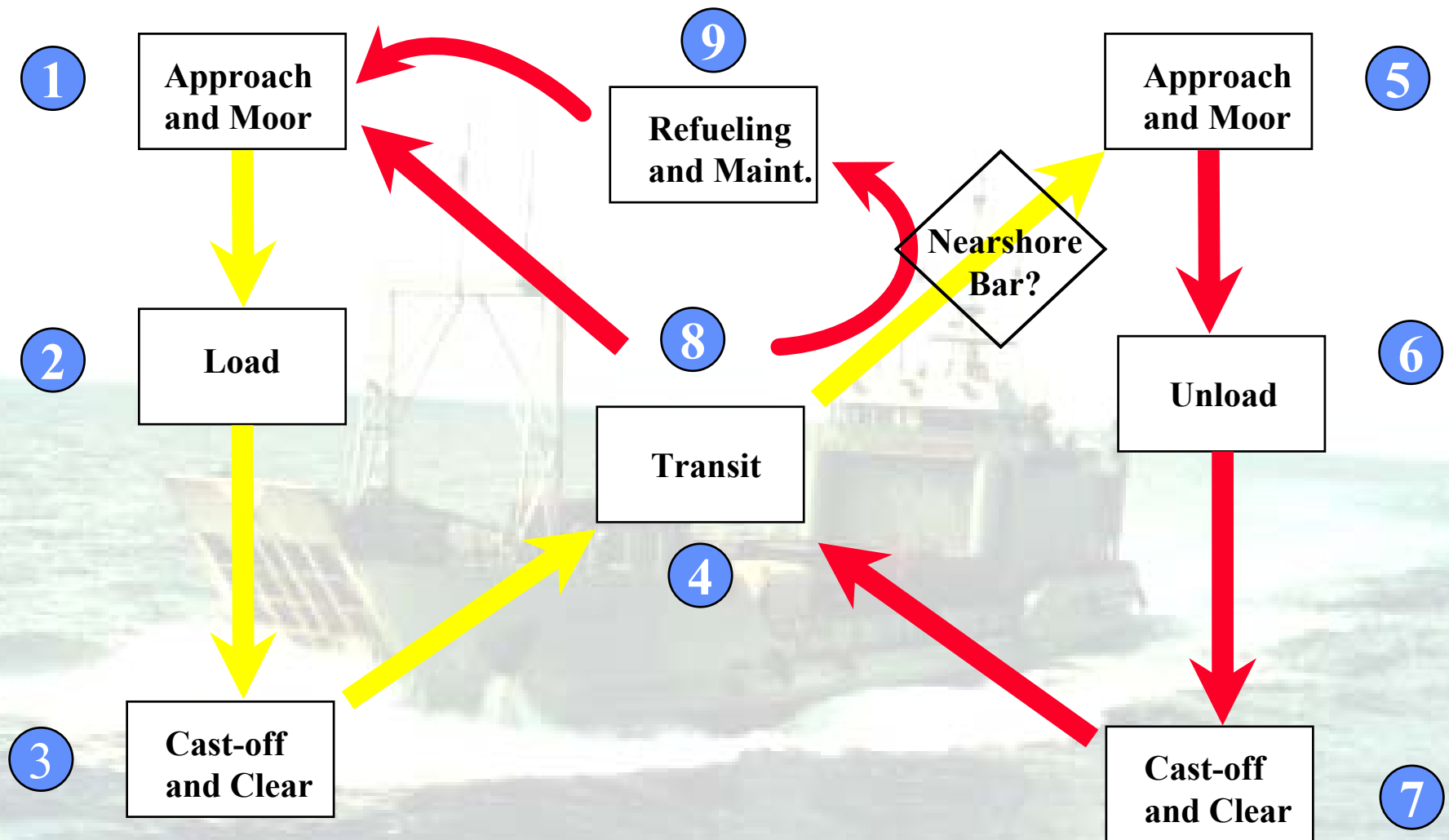- ◆ **Objective site selection**

LOTS System Characteristics

- *Nodes (ships, shore discharge)*

- *Links (lighter types)*

- *Experience (crew training levels)*

- *Environment (sea state, bathymetry, tides, beach gradient)*

- *Compatibility matrix (interoperability issues)*

- *Operations (approach & moor, cast-off & clear, loading, unloading, traveling)*

Operations Flow Diagram

1 → **Approach and Moor**

9 → **Refueling and Maint.**

5 → **Approach and Moor**

2 → **Load**

Nearshore Bar?

8 → **Transit**

6 → **Unload**

3 → **Cast-off and Clear**

4 → **Transit**

7 → **Cast-off and Clear**

$$t_i = \text{Base Time} * F_{exp} * F_{tod} * F_{ss} * F_{comp} + \text{Queue Time}$$

$$t_{total} = \Sigma \, t_i + t_{maint} + t_{fuel}$$

Features of CITM

- *PC Based*

- *Fortran Code*

- *Uses data from previous JLOTS operations*

- *Allows re-positioning of ships and offload sites*

- *Models current watercraft and off-load nodes*

- *Incorporates ICODES input for ship manifest*

- *1 minute time intervals*

- *Cumulative/recent throughput output*

Features of CITM (cont.)

• *Takes into account various factors that can affect throughput, to include the following:*

  • *Seastate conditions*

  •*Bathymetry*

  •*Tide levels*

  •*Night operations*

  •*Crew experience levels*

  •*Ship/lighter/site compatibilities*

  •*Beach clearance capabilities*

Example of Nearshore Bathymetry

A Typical Beach Profile
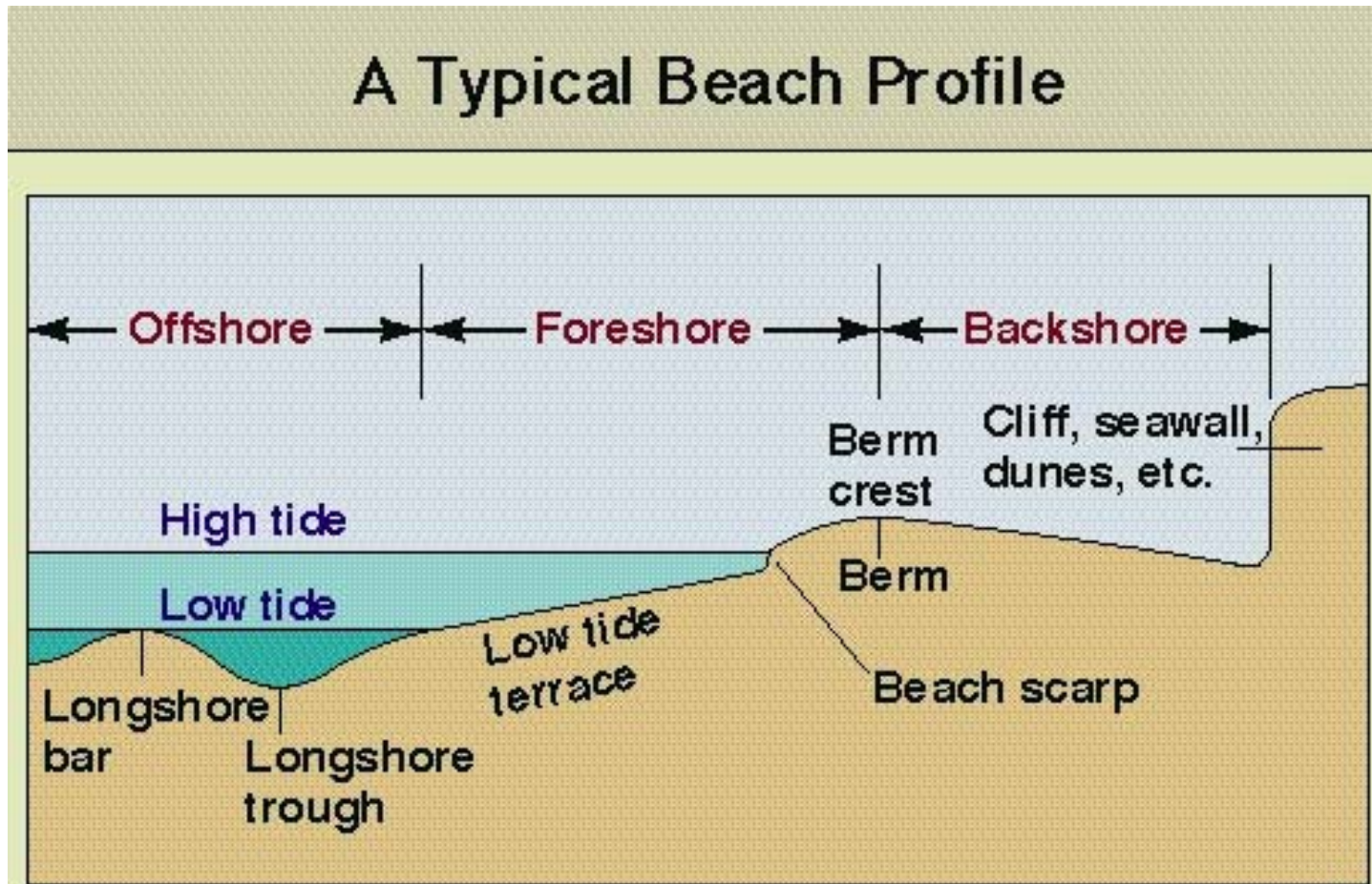
Test Case Scenario for Ft. Story and Eglin AFB

Offshore Nodes

- **1 Fast Sealift Ship (FSS)**
- **1 LMSR**

Onshore Nodes

- **1 ELCAS**
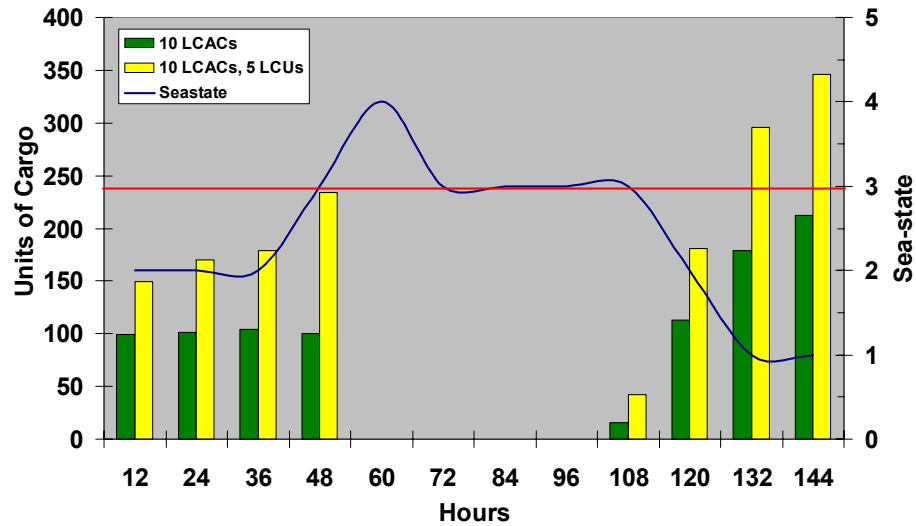- **2 Bare Beach Sites (Splashpoints)**

Conditions

- **6 total days simulated**
- **Month of February**
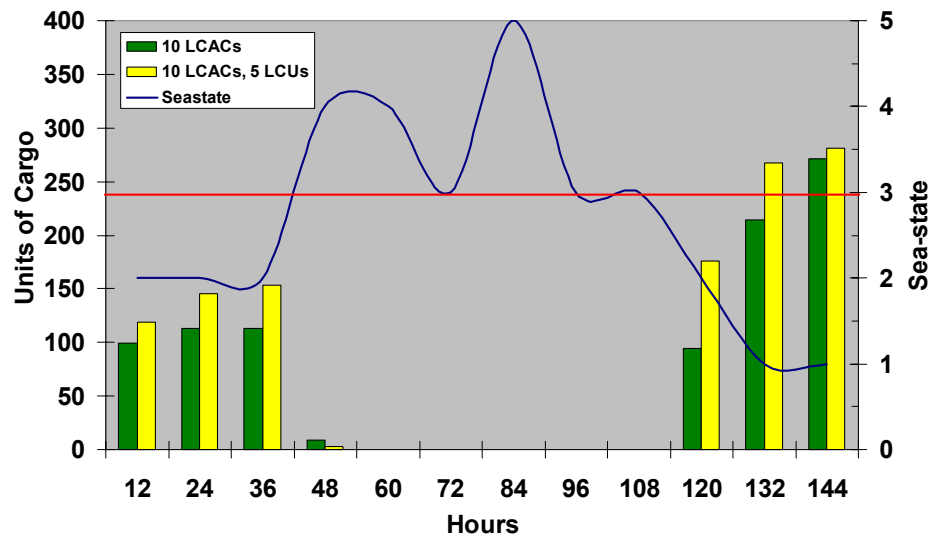- **RO/RO and LO/LO**

Environmental Data

- **Bathymetry, 1/2 mile grid**
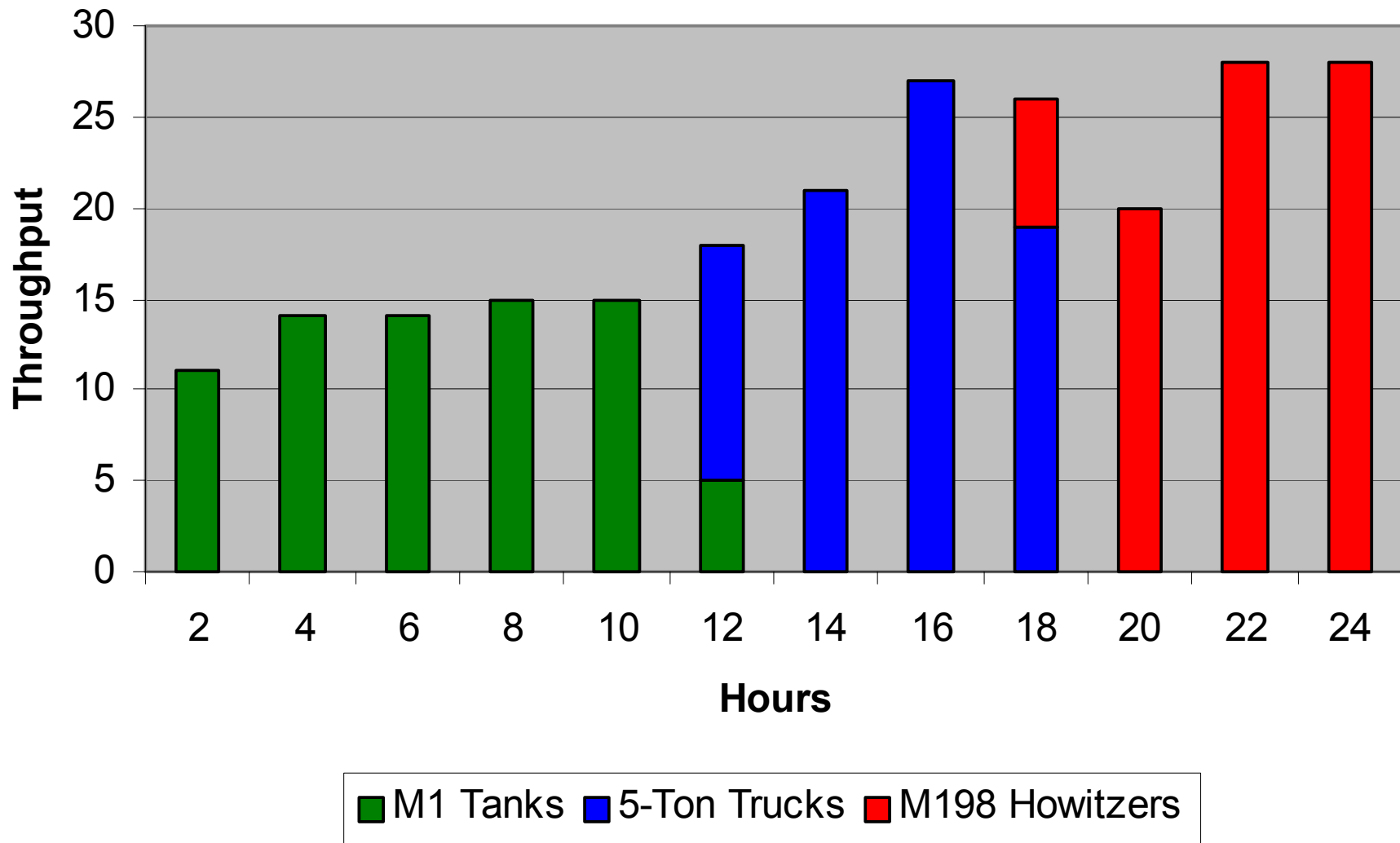- **Wave Heights (historical)**
- **Tidal fluctuations (ADCIRC)**

Ft. Story, VA

Eglin AFB, FL

Typical CITM Output Showing Prioritized Offload

Chart: Throughput vs. Hours

- Y-axis: Throughput (0, 5, 10, 15, 20, 25, 30)
- X-axis: Hours (2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24)

Legend:
- ■ M1 Tanks (green)
- ■ 5-Ton Trucks (blue)
- ■ M198 Howitzers (red)

CITM Support to War Planners

- Real World:
  - Balkan theater of operations throughput analysis (classified)

- War-fighter Exercises:
  - Ulchi Focus Lens (UFL)
    - Throughput analysis
    - JLOTS site evaluations
    - East coast Korea
  - RSO&I
    - Throughput analysis
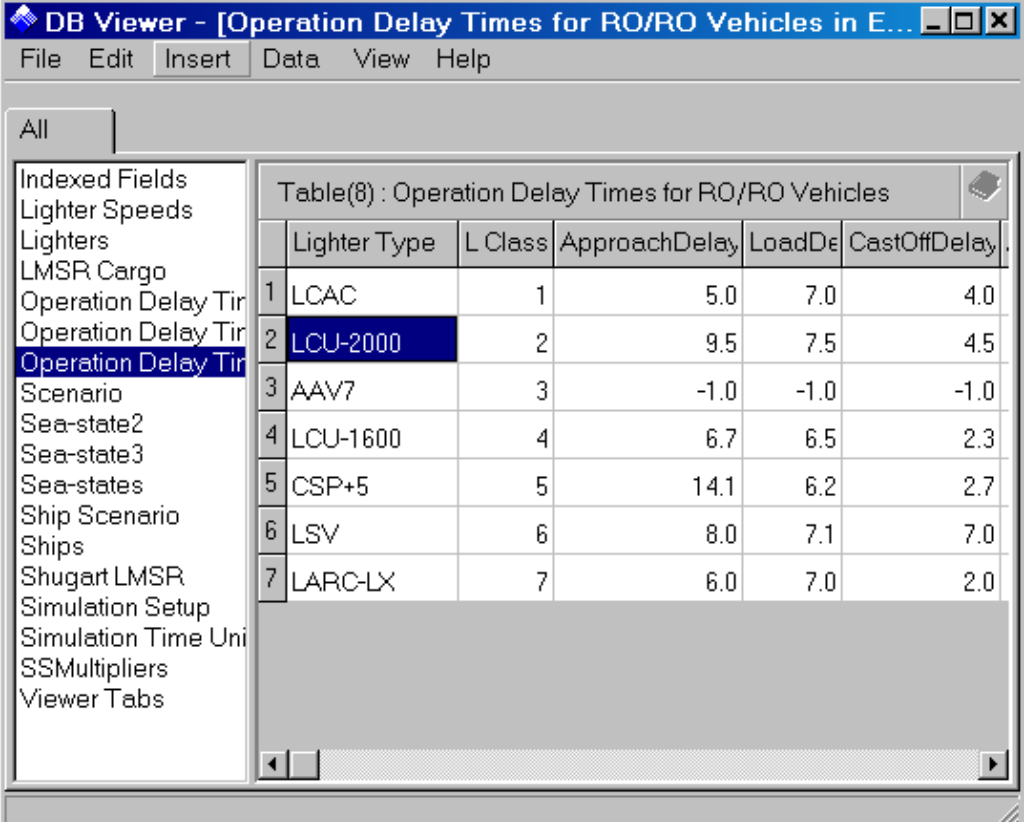   - JLOTS site evaluations
    - East and West coast Korea

Converting CITM to Extend

- **Obstacles to overcome**
  - **Learning a new software language**
  - **CITM was written in Fortran**
  - **Needed to change from being a time-driven simulation to an event-driven simulation**

- **Advantages**
  - **Flowchart**
  - **Algorithms**
  - **Data**

Converting CITM to Extend

- **Screenshot of Database Viewer**

- **Includes:**
  - **Lighter characteristics**
  - **Ship characteristics**
  - **Sea-state data**
  - **Delay times for lighter operations**
  - **Ship's cargo**

DB Viewer - [Operation Delay Times for RO/RO Vehicles in E...]

File   Edit   Insert   Data   View   Help

All

Indexed Fields
Lighter Speeds
Lighters
LMSR Cargo
Operation Delay Tir
Operation Delay Tir
Operation Delay Tir
Scenario
Sea-state2
Sea-state3
Sea-states
Ship Scenario
Ships
Shugart LMSR
Simulation Setup
Simulation Time Uni
SSMultipliers
Viewer Tabs

Table(8) : Operation Delay Times for RO/RO Vehicles

	Lighter Type	L Class	ApproachDelay	LoadDe	CastOffDelay
1	LCAC	1	5.0	7.0	4.0
2	LCU-2000	2	9.5	7.5	4.5
3	AAV7	3	-1.0	-1.0	-1.0
4	LCU-1600	4	6.7	6.5	2.3
5	CSP+5	5	14.1	6.2	2.7
6	LSV	6	8.0	7.1	7.0
7	LARC-LX	7	6.0	7.0	2.0

Converting CITM to Extend

Notebook - ExtendCITM2Deb31.mox

Define Your Scenario

Select the type and quantity of lighters

LCU–2000	4
LSV	2
LCAC	5
CSP+5	1
None	0
None	0
None	0

Enter the total number of ships in your scenario **2**

Based on the table of ship configurations below, select each ship type

LMSR-1 = 1 RRDF w/2 offload points
1 crane offload point
LMSR-2 = 1 RRDF w/2 offload points
1 RRDF w/1 offload point
1 crane offload point
LMSR-3 = 1 RRDF w/2 offload points
2 crane offload points
LMSR-4 = 1 RRDF w/1 offload point
2 crane offload points

FSS-1 = 1 RRDF w/1 offload point
1 crane offload point
FSS-2 = 1 RRDF w/1 offload point
2 crane offload points
FSS-3 = 1 RRDF w/1 offload point
1 crane offload point

T-ACS
LMSR-2
None

Enter the distance the ships are from shore (in miles) **1**

Enter the total number of offload sites in your scenario **2**

Select each type of offload site below

Floating Pier – 1 offload point
Bare Beach
None
None
None

Start Date & Time 2/8/2004 12:00 AM Sun
End Date & Time 2/10/2004 12:00 AM Tue

Click to turn animation off **Animation off**

Click to turn animation on **Animation on**

Done

Select the average experience level of the stevedore crews
Some Training, Some Experience

Enter predominant Sea-State Conditions for your simulation run (1, 2 or 3) **2**

Development of Future Modeling Tools for Force Projection

Capabilities must include

- throughput rate prediction
- site selection
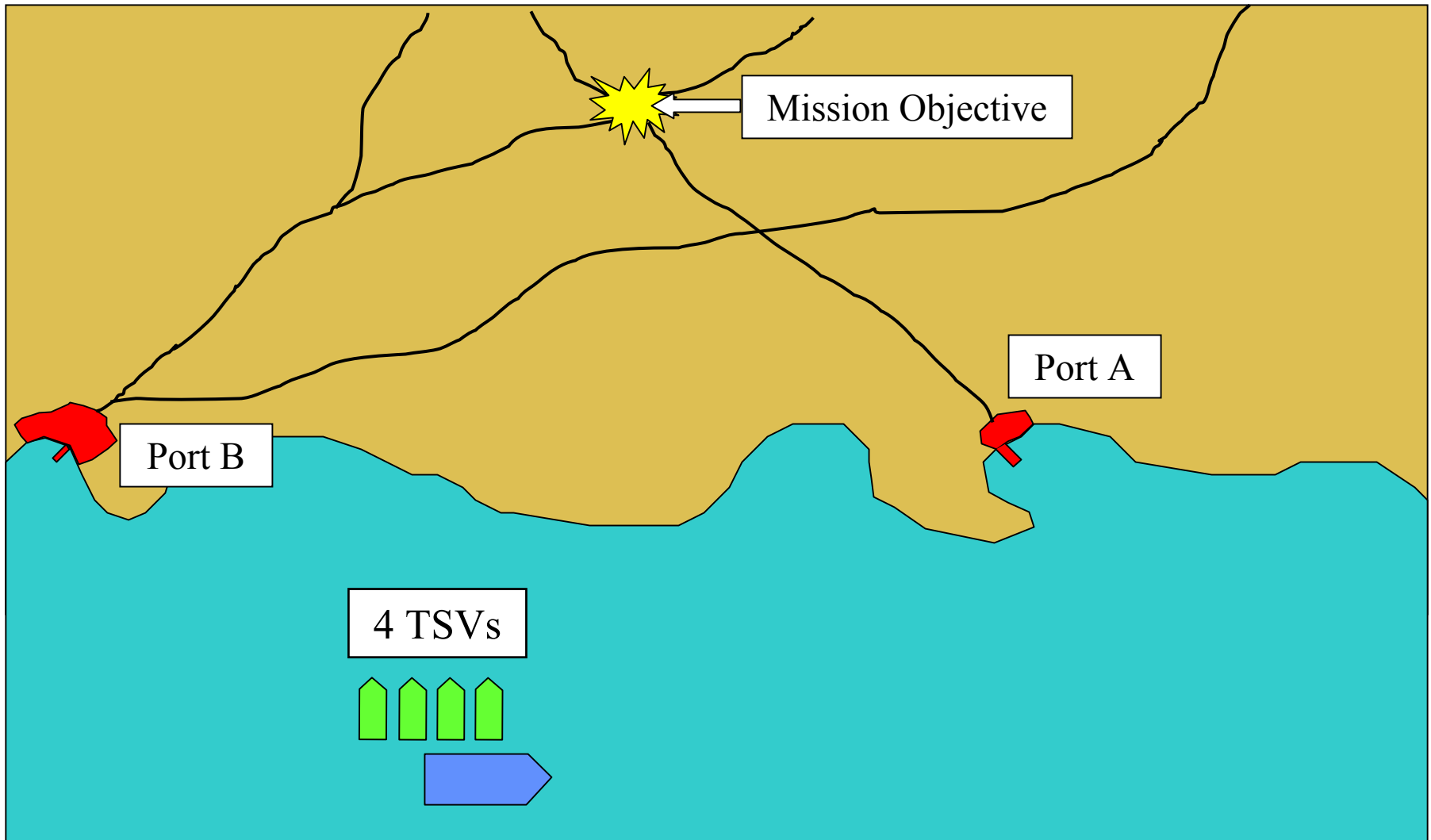- RPE impact assessment and tool selection

Future Force Projection From the Sea (Small Ports)
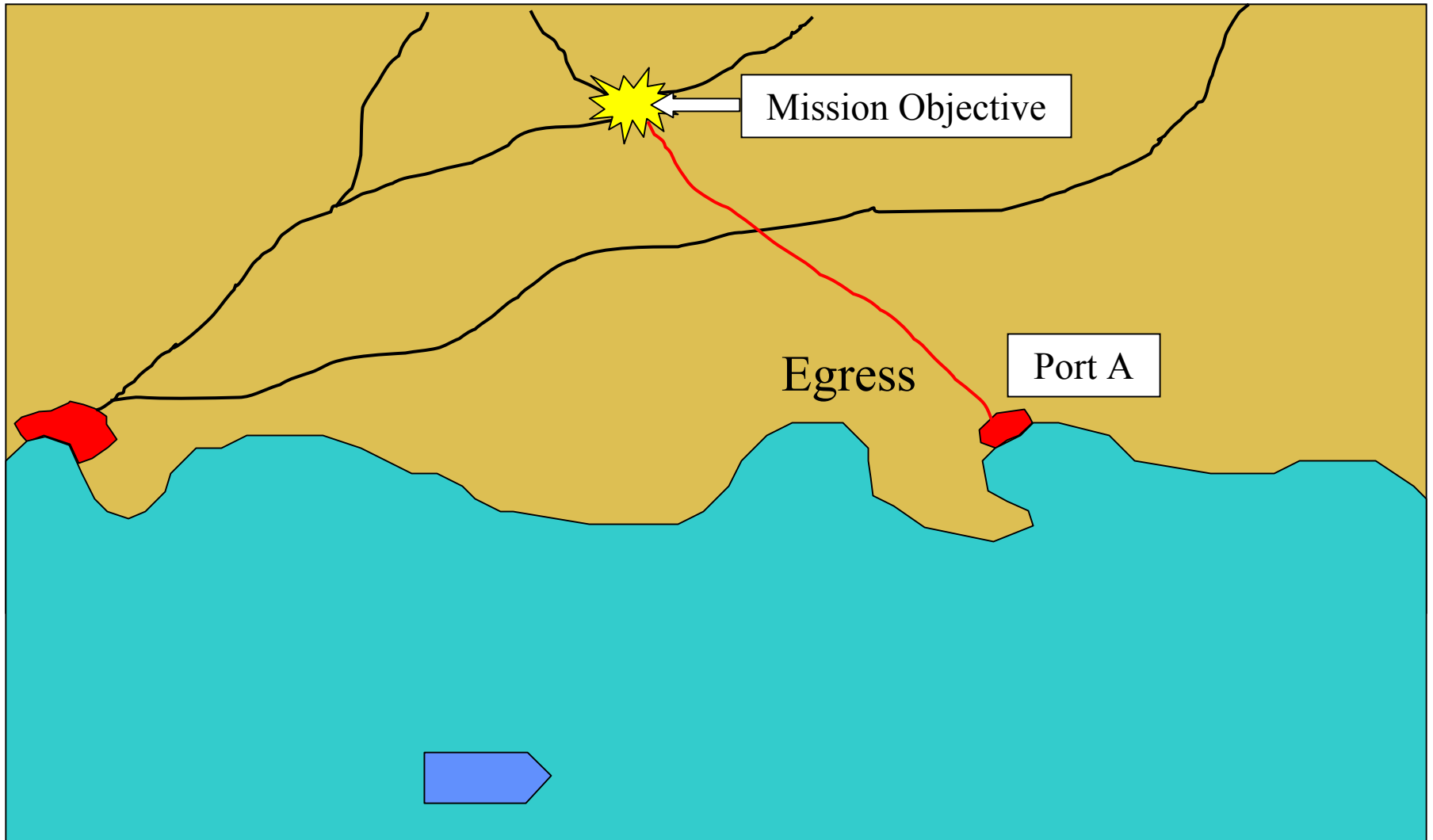
Three different aspects to site selection

- throughput potential
- potential threat (bridges, tunnels, topography)
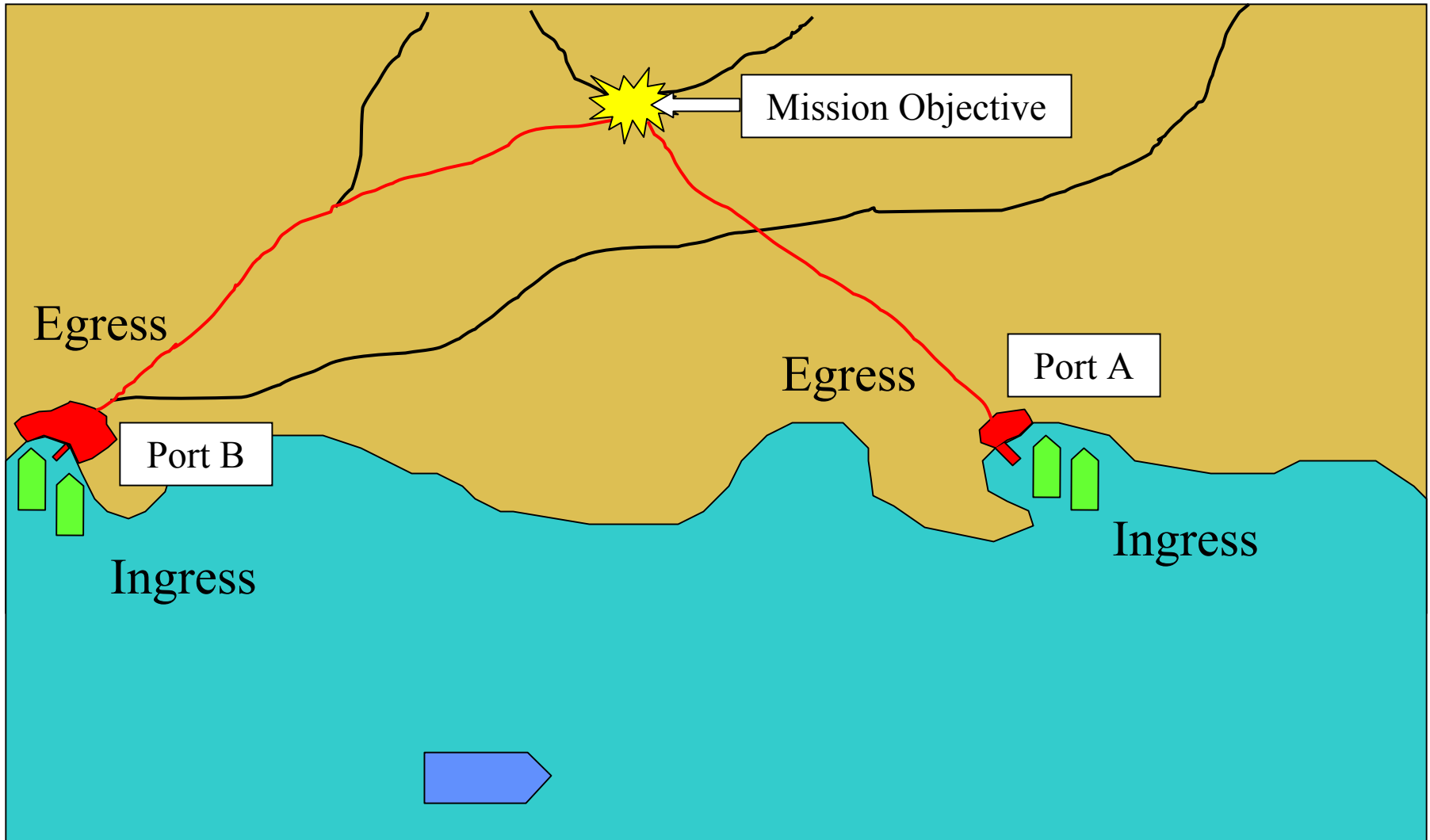- maneuver advantage

Example Scenario

Mission Objective

Port A

Port B

4 TSVs

Scenario 1

Mission Objective

Egress

Port A

Scenario 2

Mission Objective

Egress

Port B

Ingress

Scenario 3

QUESTION(S)?